Beneficial Insect Lab
Annual Report of Activities
1998

Small Hive Beetles (*Aethina tumida)* and Honey Bee

North Carolina Department of Agriculture
&
Consumer Services

James A. Graham, Commissioner

1998 REPORT OF ACTIVITIES

Beneficial Insects Laboratory
Plant Protection Section
North Carolina Department of Agriculture & Consumer Services
P.O. Box 27647
Raleigh, NC 27611

http://www.agr.state.nc.us/plantind/plant.htm

Introduction

This report is a summary of the projects undertaken by the Beneficial Insects Laboratory (BIL) of the Plant Industry Division of the North Carolina Department of Agriculture and Consumer Services during 1998. The BIL addresses two programs, biological control and apiary inspection. The Biocontrol program implements classical biological control projects, in which the natural enemies of pest insects and weeds are released in the environment with the goal of stabilizing pest populations below their economic threshold. The Apiary Inspection program, supervised by Don Hopkins, State Apiarist, is designed to maintain a viable bee and honey industry in North Carolina through inspection for mites, diseases, and other hive pests. Mr. Hopkins and his field inspectors also provide demonstrations and educational talks to the general public.

One of the most recent invaders to our state is the small hive beetle, <u>Aethina</u> <u>tumida</u> Murray (Coleoptera: Nitidulidae), and it is featured on our cover this year. The picture was taken by Todd Lowe, former Richmond Co. Cooperative Extension Agent. A native to South Africa, the beetle had been found during the summer of 1998 in South Carolina, Florida and Georgia. It was found in North Carolina for the first time in November 1998. Little is known about the biology of this pest, but our evidence to date suggests that it may cause severe damage to honey bee colonies.

The cooperative extension service, faculty, and staff of North Carolina State University, USDA-APHIS and ARS all played roles in the implementation of our programs during 1998. We are grateful for the cooperation of other members of the NCDA Plant Protection Staff, including Support Services, the statewide field staff under the supervision of John Scott, Mike Massey, and Lloyd Garcia, and the identification service provided by NCDA taxonomist Kenneth Ahlstrom.

Implementation of our 1998 programs included release of a total of 406 beneficial insects, an entomopathogenic fungus, and a microsporidian; all introductions originated from out of state. Cooperative work with USDA-APHIS-ARS for cereal leaf beetle continued during 1998; the ash whitefly project was terminated in September. Parasitized cereal leaf beetle larvae were sent to Georgia and Alabama for their insectaries, and weevils for thistle control were sent to South Carolina. Studies on the biology of the adventive predator <u>Harmonia</u> <u>axyridis</u> continue. Thistle biological control continued in 1998, and a study was initiated on Japanese knotweed (<u>Fallopia</u> <u>japonica</u>), with the assistance of the Forest Health Technology Enterprise Team of the US Forest Service.

The Quarantine Facility housed at the laboratory has been used by entomologists from NCSU, Rhone-Poulenc Ag Co. and by our own personnel. Janet Shurtleff, Ph.D., serves as the Quarantine Officer, and welcomes inquiries about the facility.

One paper was published by BIL personnel during 1998:

Nalepa, C.A., K.R. Ahlstrom, B.A. Nault and J.L. Williams. 1998. Mass appearance of lady beetles (Coleoptera: Coccinellidae) on North Carolina beaches. Entomol. News. 109(4): 277-281.

The personnel of the BIL during 1998 were:

Ms Kathleen Kidd, Biological Control Administrator
Dr. Christine Nalepa, Laboratory Research Specialist
Dr. Janet Shurtleff, Quarantine Officer
Dr. Robin Goodson, Agricultural Research Technician
Ms Gloria Johnson, Office Assistant (through October, 1998)
Ms Jamie Meadows, Office Assistant (since November 1998)
Mr. Doug Huffman, Plant Pest Aide
Ms Amanda McCullen, Summer Intern
Ms Joan Schmidt, Plant Pest Aide

Mr. Donald Hopkins, State Apiarist and Apiary Inspection Supervisor
Mr. Glenn Hackney, Agricultural Research Technician
Mr. Adolphus Leonard, Eastern Area Apiary Inspector
Mr. William Sheppard, Sandhills Area Apiary Inspector
Mr. Richard Lippard, Western Piedmont Area Apiary Inspector
Mr. Jack Hanel, Mountain Area Apiary Inspector

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K.A. Kidd and C.A. Nalepa
Editors
14-IV-99

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Records of Beneficial Organisms
Released by the NCDA & CS
Beneficial Insect Laboratory, 1998

Date	Host	Beneficial	No.	Source	County/Location
24 April	Oulema melanopus	Tetrastichus julis	17A	France/ Greece	Rowan/Piedmont RS
28 April	Oulema melanopus	Tetrastichus julis	30A	France/ Greece	Rowan/Piedmont RS
Total T. julis: 47					
28 April	Oulema melanopus	Diaparsis temporalis	157A	France/ Greece	Rowan/Piedmont RS
30 April	Oulema melanopus	Diaparsis temporalis	102A	France/ Greece	Washington/Tidewater RS
6 May	Oulema melanopus	Diaparsis temporalis	120A	France/ Greece	Rowan/Piedmont RS
Total D. temporalis: 359					
16 September	Solenopsis invicta	Thelohania solenopsae	25 gIL	USDA-ARS-CMAVE	Sampson/Garland
10 December	Lymantria dispar	Entomophaga maimaiga	60 IL	Currituck Co.	Macon/Highlands

A = adults
IL = infected larvae
RS = research station

GRAND TOTAL: a total of 406 insects and two species of pathogen were released in North Carolina in 1998.

NCDA & CS Beneficial Insects Laboratory

Summary of Quarantine Activities 1998

A total of 13 shipments of foreign material were received by the NCDA & CS Insect Quarantine Facility during 1998, and one received in 1995 remained in the facility.

ID #	SPECIES	FAMILY	STAGE	#	ORIGIN	STATUS
Q95-1	Tiphia popilliavora	Tiphiidae	pupae	190	China	Part of shipment emerged in quarantine and was preserved, remainder died in quarantine
Q97-1	Blattella germanica	Blattellidae	adults/ nymphs	50	Japan	Insects received in this shipment are still being maintained in quarantine
Q97-2	Lymantria dispar	Lymantriidae	larvae	366	NC	Insects dissected and autoclaved
Q97-4	Tetrastichus julis Diaparsis temporalis Lemophagus curtus	Eulophidae Ichneumonidae Ichneumonidae	pupae pupae pupae	100 500 500	France/ Greece	Part of shipment emerged in quarantine and was preserved, remainder released.
Q97-5	Trichogramma exiguum	Trichogrammatidae	larvae/ pupae	28,400,000	France	Released from quarantine. Insects originally from US, reared in France, and shipped back for release in NC
Q98-1	Plutella xylostella	Plutellidae	eggs	2,000	Thailand	Emerged in quarantine; larvae used in studies in quarantine, colony autoclaved.
Q98-2	Arthina tumida	Nitidulidae	adults	50	NC	Colony being maintained in quarantine for research
Q98-3	Arthina tumida	Nitidulidae	adults	80	NC	Colony being maintained in quarantine for research

Ash Whitefly

Doug Huffman

The ash whitefly (AWF), Siphoninus phillyreae (Haliday) (Homoptera: Aleyrodidae), was found on Bradford pear trees in Raleigh, NC in 1993, and subsequent surveys showed that it was widely distributed in Wake County. A biological control program was initiated against this pest, and a parasitic wasp, Encarsia inaron (Walker) (Hymenoptera: Aphelinidae) was released during 1994-95. The parasitoid has been recovered annually at release sites and has dispersed away from those sites.

Monitoring continued in Wake Co. in 1998. Although numbers of ash whitefly increased through the season, populations did not appear to reach levels that are aesthetically or physically detrimental to the ornamental hosts. As in previous years, the parasitoid was recovered in late August at most locations. To date, we have not been able to identify an alternate host for the parasitoid but believe there is one, based on this late annual appearance. For the first time, Encarsia inaron was recovered in Garner, and an infestation of parasitized AWF was reported in Fayetteville. As an aid to identification, an insect note was compiled and placed on the World Wide Web through the NC Cooperative Extension Service. This may be viewed or downloaded at:

http://www.ces.ncsu.edu/depts/ent/notes/Ornamentals_and_Turf/trees_contents/orn_t113/not113.html

Release of a Microsporidian on Imported Fire Ant

C.A. Nalepa

On 16-17 September 1998, the Beneficial Insects Laboratory, together with field personnel Terry Smith and Larry Henderson, cooperated with Dr. David Oi of USDA-ARS CMAVE (Gainesville) in the release of the microsporidian Thelohania solenopsae on imported fire ant mounds (Solenopsis invicta) in North Carolina. One control and one treatment plot (1/4 acre each) were established approximately one mile apart in pastures near Garland, in Sampson County. All fire ant mounds in each plot were counted, measured, sampled and mapped. Separate grids of pitfall traps and baits were used to determine the identity and relative number of all ant species present in the plots. Five grams of fire ant brood infected with T. solenopsae was added to each of five disturbed mounds in the treatment plot. The first follow up samples of workers and larvae were collected on 17 November 1998; no mounds yet showed signs of infection. Monitoring will be continued in 1999.

Biological Control of Thistles

Robin L. Goodson

The rosette weevil Trichosirocalus horridus and the flowerhead weevil Rhinocyllus conicus (Coleoptera: Curculionidae) are now widely established in North

Carolina for biological control of musk thistle (Carduus nutans). Individuals can now effectively collect and redistribute the weevils at a local level. Roadside musk thistle sites were monitored where flowerhead weevils were released in summer 1997 in cooperation with the N.C. Department of Transportation; R. conicus populations were found to be successfully established at all such roadside release sites. In light of troubling reports from the western and midwestern United States, R. conicus was not detected feeding on native non-target thistle species in North Carolina, and we received no such reports. Operating under appropriate federal and South Carolina permits, approximately 1,000 R. conicus weevils were transported to South Carolina and released in cooperation with local cooperative extension personnel and farmers on musk thistle-infested pasture in Abbeville and Anderson Counties. As their populations increase at sites where original releases were made during 1997, the bull thistle flowerhead-feeding fly Urophora stylata (Diptera: Tephritidae) will be redistributed in North Carolina for biological control of bull thistle (Cirsium vulgare).

Fall Cankerworm

Robin L. Goodson

A project was initiated in Charlotte, to use biological control agents to manage a large population of fall cankerworm (Alsophila pometaria) which has persisted for a number of years, feeding primarily on old willow oaks in the city. Preliminary work to test rearing and collecting methods was undertaken, and an attempt was made to collect an aggressive strain of native parasitoids in Virginia. This work will continue in 1999.

Lady Beetles (Coccinellidae)

C.A. Nalepa and K.A. Kidd

Studies were planned to investigate the cues used by Harmonia axyridis during flight and aggregation behavior. The low number of adults that arrived in the Raleigh area in fall 1998, however, allowed us to conduct only preliminary studies; the experiments will be continued in 1999. We collected adults from two sites to dissect for parasitism levels. In one site (Upchurch – Alleghany Co.) no parasites were found (n = 30), in the other, one larva of Strongygaster triangulifera was found (n = 18; 5.6% parasitism).

Azalea Seed Pod Insects

C. A. Nalepa, D. L. Stephan[1], and K.R. Ahlstrom

[1]North Carolina State University

In response to a request from Ed Collins, president of the American Southeastern Chapter of the American Rhododendron Society, an investigation was made into the source of widespread damage to the seeds and seed pods of native any hybrid azaleas in the North Carolina mountains. The damage was of concern because members of the Society are hybridizing and growing native azaleas from seed.

Fourteen seed pod samples (azalea, Rhododendron sp., mountain laurel, Leucothoe sp.) were collected on 24 September 1998 from two sites (Collins property and the N.C. Arboretum) in Henderson County, NC; two samples from an additional site were collected previously by Ed Collins. All samples were held at room temperature and monitored for almost a month after collection. A subsample of each was examined externally, then dissected. All samples exhibited holes in the walls of the seed capsule. Two insect species emerged from the collected samples:

1)Kleidocerys resedae (Panzer) (Family: Lygaeidae) was present in half the samples; both nymphs and adults emerged. K. resedae is quite commonly collected in North Carolina, and the host records in the N.C. State University Insect Collection indicate that it is found on, among others plants, cedar, sycamore, hemlock, Virginia pine, birch and azalea.

2) Scambus hispae (Harris) (Hymenoptera: Ichneumonidae). One male was collected from one sample. The species is a known parasite of several Lepidoptera.

The following was also noted or collected from the dissected samples: 1) head capsule of a probable larval weevil (Coleoptera: Curculionidae), and 2) a larval tortricid moth (dead) probably Platynota (Lepidoptera: Tortricidae). The following was obtained from the material previously collected by Ed Collins: 1) puparia (n=16) of an undetermined fly, and 2) a larval tortricid moth, probably Platynota (Lepidoptera: Tortricidae). The fly puparia were held at ambient temperature until March 1999; fungal growth was evident and no adult flies emerged.

The results of the study indicate that a complex of insects may be responsible for the observed damage to the seed pods. It was recommended that subsequent studies to determine the identity and dynamics of the culprits be initiated earlier in the season.

We thank Bob Blinn, North Carolina State University Insect Museum, for the identification of K. resedae.

Cereal Leaf Beetle Parasitoid Insectary Program, 1998

K.A. Kidd

The cereal leaf beetle (Oulema melanopus (L.)) (CLB) (Coleoptera: Chrysomelidae) is a small grains pest native to the Palearctic region. This species was first identified in the United States in Michigan in 1962, and it has been present in North Carolina since 1977. The first infestations of CLB found in NC were in 19 counties, primarily along the Virginia border; This insect has since expanded its range to include all of the grain growing regions of the state. CLB can cause severe damage to the leaves of wheat, oats, barley and other cereal crops; when heavy feeding occurs, grain yields may be reduced.

After the insect was discovered in the US and efforts to quarantine and eradicate it were unsuccessful, a biological control program was initiated in 1963 (Haynes and Gage 1981). Parasitoids were collected in Europe, and parasitoid nurseries (or field insectaries) were established in Michigan and other midwestern states by the late 1960's; field days were held to distribute parasitoids to regional extension personnel and farmers. One species of egg parasitoid and three species of larval parasitoids were originally imported from Europe by USDA, and all have been released in North Carolina. Anaphes flavipes (Foerster) (Hymenoptera: Mymaridae) (the egg parasitoid) was released as early as 1978. This species disperses well and is not reared in insectaries; it is released and allowed to spread on its own. Three larval parasitoids, Tetrastichus julis (Walker) (Hymenoptera: Eulophidae), Diaparsis temporalis Horstmann (Hymenoptera: Ichneumonidae) and Lemophagus curtus Townes (Hymenoptera: Ichneumonidae) have also been released.

In 1978, the first parasitoid releases were made in North Carolina, and a field insectary program, similar to the program in Michigan, was started in the fall of 1987. In 1998 insectaries were located at the Tidewater Research Station near Plymouth, Oxford Research Station near Oxford, and the Piedmont Research Station near Salisbury. The Piedmont insectary is the only one that has had perennial populations of CLB and Tetrastichus julis; T. julis has been recovered at Oxford, but CLB populations are low. No parasitoids had been recovered at Tidewater until 1998.

Materials and Methods

Descriptions of the parasitoid insectaries may be found in previous reports (Kidd and Bryan 1993, 1994). Although each insectary follows a different planting design, they all consist of two or four plots, each of which is divided into two or more subplots. All have fall wheat followed by a spring plantings of oats. No-till planting methods are used throughout.

Beginning in late March or early April of 1998, insectaries were monitored every 7-19 days. Presence of CLB adults in the early spring was determined using sweep net samples; after eggs and larvae were detected, the presence of adults was noted during visual inspection of the plants. To determine population densities of the eggs and larvae, three samples of one square foot each were taken in each subplot. Each sample consisted of counts of all eggs and larvae on 20.5 inches of small grain row, and the three counts were averaged for each subplot. After larvae were detected in the field, samples of larvae were removed and examined for the presence parasitoids. Larvae were dissected for parasitoid eggs or larvae by K.R. Ahlstrom, NCDA&CS, Plant Industry taxonomist. Adult T. julis and D. temporalis were released in the Piedmont and Tidewater Insectaries.

Adult T. julis and D. temporalis were released in the Piedmont and Tidewater Insectaries. These insects had been collected in France and Greece during 1997, and held in the NCDA &CS quarantine facility until emergence in April 1998. Numbers released may be found elsewhere in this volume.

Results and Discussion

Populations of cereal leaf beetle were moderate at the Piedmont insectary and low at the Tidewater and Oxford insectaries (Table 1). At the Piedmont insectary, the highest egg density was found on 7 April in all but the youngest plots. Highest larval populations occurred 28 April in the fall wheat and first oat plantings, and 13 May in the younger oat plantings. At the Tidewater insectary, highest egg and larval populations occurred between 13 April. Oat plantings were not successful at the Tidewater station, and only a few plants were present; all data, therefore, was collected from wheat planted in the fall.

The larval parasitoid T. julis persists at the Piedmont insectary, and it was recovered for the first time at the Tidewater insectary, on 14 May, when most of the CLB had already pupated (Table 2). Rates of larval parasitism at the Piedmont insectary were high at the end of the season, and parasitized larvae were sent to Alabama and Georgia for release in insectaries there. In cooperation with the Niles Biological Control Laboratory, two new methods for Anaphes flavipes egg detection were tested, but equipment was received too late in the season to evaluate. We hope to test these methods in 1999. The presence of A. flavipes in insectaries is known to reduce the number of larvae available for late T. julis.

Acknowledgements

Numerous individuals contributed to this project, and the list includes, but is not limited to John VanDuyn, Stephen Bambara (NCSU), Raymond Coltrain, Ray Horton, Bill Clements, John Smith (Research Stations), and Ron Day (grower).

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Table 1. Cereal Leaf Beetle Populations, 1998

Piedmont Research Station, Salisbury

	Wheat		Oats (1)		Oats (2)		Oats (3)	
Date	Eggs*	Larvae*	Eggs*	Larvae*	Eggs*	Larvae*	Eggs*	Larvae*
31 Mar	3.8 (1.5)	0.0 (0.0)	17.8 (5.8)	0.7 (0.7)	15.8 (8.3)	0.3 (0.0)	0.0 (0.0)	0.0 (0.0)
7 Apr	12.2 (3.9)	1.2 9 (0.9)	22.3 (0.7)	0.7 (0.7)	11.3 (11.0)	0.0 (0.0)	0.2 (0.2)	0.0 (0.0)
15 Apr	2.0 (0.3)	1.8 (0.2)	7.7 (2.7)	7.0 (1.3)	5.0 (4.0)	0.2 (0.2)	3.9 (0.6)	0.0 (0.0)
21 Apr	1.3 (0.0)	4.3 (1.0)	3.7 (0.0)	8.0 (0.3)	2.3 (1.3)	0.2 (0.2)	3.5 (3.2)	0.0 (0.0)
28 Apr	0.3 (0.3)	4.8 (1.5)	1.7 (0.4)	8.2 (5.8)	3.3 (1.3)	0.2 (0.2)	3.8 (1.8)	0.8 (0.2)
6 May	0.2 (0.2)	2.2 (1.2)	4.2 (2.2)	6.0 (3.7)	5.5 (0.5)	1.8 (0.7)	4.5 (0.8)	0.5 (0.2)
13 May	0.0 (0.0)	0.5 (0.5)	1.8 (1.8)	3.0 (1.3)	2.2 (0.2)	2.2 (0.2)	5.3 (1.7)	1.5 (0.5)
20 May	0.0 (0.0)	0.0 (0.0)	0.3 (0.3)	0.8 (0.2)	1.5 (0.5)	0.7 (0.4)	0.4 (0.4)	0.7 (0.7)
28 May	--	--	--	--	0.7 (0.0)	0.0 (0.0)	0.2 (0.0)	0.0 (0.0)

Tidewater Research Station, Plymouth

	Wheat	
Date	Eggs*	Larvae*
3 Apr	3.0 (2.0)	3.8 (0.3)
13 Apr	5.4 (3.9)	4.3 (0.8)
30 Apr	1.2 (0.2)	1.5 (0.5)
7 May	0.0 (0.0)	0.3 (0.0)
14 May	0.0 (0.0)	0.2 (0.2)
21 May	0.0 (0.0)	0.0 (0.0)

Oxford Research Station

	Wheat	
Date	Eggs*	Larvae*
9 Apr	2.7 (0.7)	0.3 (0.3)
16 Apr	1.0 (1.0)	0.7 (0.4)
5 May	0.0 (0.0)	0.7 (0.4)

* Mean # eggs or larvae/square foot (±SE).

Table 2. Cereal Leaf Beetle Parasitism, 1998

Piedmont Research Station, Salisbury
% Parasitized Larvae*

Date	Wheat	Oats (1)	Oats (2)	Oats (3)
15 Apr	10.0% (40)	14.3% (21)	--	--
21 Apr	6.8 (117)	15.2 (99)	16.0% (25)	0.0 (5)
28 Apr	2.8 (107)	14.9 (70)	--	--
6 May	2.4 (82)	1.0 (104)	8.3 (24)	0.0 (30)
13 May	0.0 (23)	2.8 (71)	14.8 (27)	12.0 (25)
20 May		81.8 (11)	100.0 (12)	100.0 (9)

Tidewater Research Station, Plymouth

Date	% Parasitized Larvae*
13 Apr	0.0% (229)
30 Apr	0.0 (122)
7 May	0.0 (99)
14 May	41.1 (17)

*Larvae were parasitized by Tetrastichus julis. Numbers shown are % parasitized (sample size).

Entomophaga maimaiga Infection in Gypsy Moth Larvae – 1998

Janet L. Shurtleff

Soil infested with Entomophaga maimaiga was distributed around trees in 11 North Carolina locations in November 1996 to determine whether this disease organism could cause significant mortality of gypsy moth in areas where other control methods are not appropriate. A total of 304 gypsy moth larvae were collected weekly in three collections in late May and early June 1998. Larvae were collected from burlap bands on the same trees used in this study in 1997.

Most of the larvae died of stress or emerged healthy as adults (69%). However, 31% died of either E. maimaiga infection with NPV (nuclear polyhedrosis virus). This represents a substantial increase in the rate of infection compared to 1997.

Disease	% of Total-1997	% of Total-1998
Entomophaga maimaiga	6	21
NPV	5	
Both (E. maimaiga & NPV)	1	5

Parasitism killed 1% of the gypsy moth larvae. This level was roughly comparable to 1997. Lespesia aletiae (Diptera: Tachinidae) and Hyphantrophaga virilis (Diptera: Tachinidae) were found in 1997 and 1998.

Larvae infected with E. maimaiga were found at all sites sampled. However, the majority of the infected larvae were collected from the new Old Trap, Riviera Motel and Rest Stop locations. Larvae collected from check areas as well as treated trees were found to be infected at the above mentioned locations.

Infected larvae were collected on all collection dates, with nearly twice as many infected 6/3/98 and 6/10/98 as larvae collected on 5/27/98. This year no conidia were found on any of the specimens, probably because sampling was conducted later in the season after resting spore formation was begun.

Insects Associated with Japanese Knotweed (Fallopia japonica) and Sakhalin Knotweed (Fallopia sachalinensis) (Polygonaceae) in North Carolina

Robin L. Goodson

Japanese knotweed (Fallopia japonica = Polygonum cuspidatum) and Sakhalin knotweed (Fallopia sachalinensis = Polygonum sachalinense) (Polygonaceae), escaped perennial ornamentals native to eastern Asia, have broad adventive ranges in North America and Europe as exotic invasive weeds (Bailey 1994; Bailey & Stace 1992; Beerling 1991, 1993; Beerling & Palmer 1994; Conolly 1977; Palmer 1994; Pysek & Prach 1993; Seiger 1991). Where introduced, Japanese knotweed is usually much more common than Sakhalin knotweed, but both plants are often found along roadsides and stream banks. When growing beside roads and associated structures, the plants must be controlled using herbicides or mowing. Perhaps more seriously, knotweed populations along stream banks threaten native plant communities and can potentially impede and alter water flow during floods. Japanese knotweed is difficult and expensive to control with herbicides and by mechanical means, and such methods do not offer permanent control (Hill 1994; Stensones & Garnett 1994; Seiger 1991, 1997).

In North Carolina, Japanese knotweed is widely distributed throughout all regions of the state (Patterson 1976, Radford et al. 1968). In addition to intentional ornamental plantings, Japanese knotweed populations are commonly found along roadways, most likely originating from the transport of rhizomes in soil used in highway construction projects. Especially in the mountains, including on and adjacent to U.S. Forest Service lands, large stands of Japanese knotweed are found along the banks of streams and rivers as a result of the downstream transport of rhizomes. In adjacent states, the Tennessee Exotic Pest Plant Council and the Virginia Native Plant Society have listed Japanese knotweed as a threat to native plant communities and ecosystems. Japanese knotweed is similarly recognized in other states and Canadian provinces.

In Europe (especially the United Kingdom), Japanese knotweed has been studied as a target weed for classical biological control (Emery 1983, Fowler & Holden 1994, Zimmerman & Topp 1991). Such work to import phytophagous insects or other natural enemies from F. japonica's native eastern Asia, however, is still at the research stage. It is possible that F. japonica and F. sachalinensis may eventually become serious targets for biological control efforts in North America. In light of this possibility, this study was conducted to gather baseline information on insects associated with F. japonica and F. sachalinensis in North Carolina; similar work might be conducted in the future in other North American regions.

Materials and Methods

A survey for insects associated with Japanese and Sakhalin knotweed was conducted during the spring and summer of 1998 in North Carolina. Thirteen sites (Table 1) (three in the mountains, four in the Piedmont, and six in the Coastal Plain) were sampled periodically. Insects were typically collected first individually by hand at each site, and then by using a sweep net; the sweep net method was the more productive. The insects were transported back to the laboratory in large plastic bags in coolers, and adult insects were mounted on insect pins.

Specimens were identified to the family level using Borror et al. (1981). Bees (Hymenoptera: Apoidea) were identified to the generic level using the keys provided by Michener et al. (1994); ant genera (Hymenoptera: Formicidae) were determined using Bolton (1994). Further identifications, mostly to the generic level, were made by comparison with determined material in the North Carolina State University Insect Collection. The identifications were intentionally conservative to avoid mistakes, and are only to the family level in some of the more challenging groups. If more detailed identifications are required, specimens should be examined by the appropriate taxonomic specialists. All specimens will be deposited in the collection of the North Carolina Department of Agriculture, Plant Industry Division.

Results and Discussion

Represented among the insects collected in association with F. japonica and F. sachalinensis is a diverse assemblage of herbivores, predators, and parasitoids (Table 2). A similar taxonomic range of insects was collected from both knotweed species. Insect feeding damage was rare, as might be expected of a non-native weedy plant. An unidentified grasshopper species feeding on F. japonica in Bladen County, and Japanese beetle (Popillia japonica) feeding on both knotweed species at numerous sites, produced the only significant insect damage detected. Bees and other nectar-feeding insects were particularly abundant at F. japonica and F. sachalinensis when in flower. Japanese knotweed is sometimes considered an important honey plant, but relatively few honey bees (Apis mellifera) were collected. Ants were commonly collected foraging on knotweed, and are possibly attracted to the plants' extrafloral nectaries. Ants also possibly protect Japanese and Sakhalin knotweed from herbivorous insects.

No further F. japonica or F. sachalinensis research is planned at this time. It is hoped, however, that this work will stimulate future consideration of Japanese knotweed and Sakhalin knotweed as targets for classical biological control in North America.

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Table 1. Japanese knotweed (JK) and Sakhalin knotweed (SK) collection sites in N.C.

Site Number	Site Location
1	Buncombe Co., Black Mountain, SR 2474, Goodson Farm, ornamental planting (JK).
2	Caldwell Co., Edgemont settlement, along stream banks (JK).
3	Caldwell Co., Winchester Rd. X Craig Creek Rd., along banks of Wilson Creek.
4	Alamance Co., near Snow Camp, SR 2346 X SR 1003, along roadside (SK).
5	Alamance Co., Greenhill Rd., ca. 1 km east of SR 2345 X SR 2346, along roadside (JK).
6	Orange Co., Hillsborough, Interstate 85 X Hwy. 86, along roadside of entrance ramp on to I-85 South (SK).
7	Wake Co., Raleigh, Method Rd., N.C. State University facility, growing at edge of woods (JK).
8	Moore Co., Southern Pines, US Hwy. 1, along roadside (JK).
9	Moore Co., Aberdeen, Hwy. 211 X Hwy. 15-501, along roadside (JK).
10	Hoke Co., McCain, Hwy. 211, along roadside (JK).
11	Bladen Co., White Lake, Hwy. 701 along roadside (JK).
12	Pitt Co., Hwy. 222, ca. 1.5 km east of Fountain, along roadside (JK).
13	Pitt Co., Hwy. 222, at north end of bridge over the Tar River, along roadside (JK).

Table 2. Insects collected on Japanese and Sakhalin knotweed in North Carolina, 1998.

Order	Family	Genus and/or species	Site, Date (no. individuals)
Orthoptera	Acrididae	unidentified	Site 11, 8-VI (10+)
Hemiptera	Pentatomidae	Euschictus sp.	Site 6, 23-VI (1)
		Hymenarcys sp.	Site 13, 11-VI (1)
	Thyreocoridae	Corimelaena sp.	Site 4, 23-VI (4)
			Site 6, 23-VI (9)
			Site 8, 8-VI (1)
			Site 9, 8-VI (3)
			Site 10, 8-VI (1)
			Site 11, 8-VI (1)
	Phymatidae	Phymata sp.	Site 7, 28-VIII (1)
			Site 12, 11-VI (2)
	Rhopalidae	unidentified	Site 6, 23-VI (2)
			Site 11, 8-VI (1)
	Reduviidae	Apiomerus crassipes	Site 9, 8-VI (1)
	Miridae	Dagbertus fasciatus	Site 9, 8-VI (1)
		Deraeocoris nebulosus	Site 7, 28-VIII (1)
		Lygus lineolaris	Site 4, 29-V (1)
			Site 5, 23-VI (1)
			Site 6, 23-VI (5)
			Site 9, 8-VI (5)
			Site 12, 11-VI (1)
			Site 13, 22-V (1)
		Stenotus binotatus	Site 4, 29-V (1)
Homoptera	Membracidae	Micrutalis sp.	Site 6, 29-V (2)
		Stictocephala sp.	Site 4, 23-VI (1)
	Cercopidae	Prosapia bicincta	Site 11, 8-VI (1)
		Clastoptera sp.	Site 4, 23-VI (1)
			Site 5, 23-VI (3)
			Site 6, 23-VI (1)

	Cicadellidae	unidentified	Site 1, 14-VII (1) Site 4, 29-V (2) Site 4, 23-VI (10) Site 5, 23-VI (6) Site 6, 29-V (1) Site 6, 23-VI (12) Site 7, 28-VIII (2) Site 8, 8-VI (4) Site 10, 8-VI (2) Site 11, 8-VI (1) Site 12, 11-VI (2) Site 13, 22-V (1) Site 13, 11-VI (2) Site 13, 17-IX (1)
	Flatidae	*Ormenoides* sp.	Site 1, 14-VII (1) Site 2, 14-VII (1)
Coleoptera	Scarabaeidae	*Popillia japonica*	Site 1, 14-VII (4) Site 4, 23-VI (10+) Site 5, 23-VI (10+) Site 6, 23-VI (10+) Site 8, 8-VI (3) Site 9, 8-VI (1) Site 10, 8-VI (4) Site 11, 8-VI (10+) Site 12, 11-VI (1)
		Trichiotinus sp.	Site 13, 11-VI (1)
	Elateridae	unidentified sp.	Site 8, 8-VI (1)
	Lampyridae	unidentified spp.	Site 1, 14-VII (1) Site 4, 23-VI (1)
	Cantharidae	*Chauliognathus* sp.	Site 4, 29-V (12) Site 4, 23-VI (1) Site 6, 23-VI (3) Site 7, 28-VIII (4) Site 9, 8-VI (2) Site 12, 11-VI (2) Site 13, 22-V (4)
	Nitidulidae	unidentified	Site 9, 8-VI (1) Site 11, 8-VI (2)
	Coccinellidae	*Brachiacantha* sp.	Site 6, 29-V (1)

	Harmonia axyridis	Site 4, 29-V (1)
		Site 6, 29-V (3)
		Site 7, 28-VIII (3)
		Site 8, 8-VI (1)
	Cycloneda sp.	Site 5, 23-VI (1)
Mordellidae	Mordellistena sp.	Site 1, 14-VII (1)
		Site 4, 23-VI (6)
		Site 6, 29-V (1)
		Site 6, 23-VI (4)
		Site 11, 8-VI (3)
Cerambycidae	Strangalia sp.	Site 4, 23-VI (2)
	Typocerus sp.	Site 6, 23-VI (1)
		Site 13, 11-VI (1)
	unidentified sp.	Site 9, 8-VI (1)
Chrysomelidae	Bassareus sp.	Site 6, 23-VI (1)
	Charidotella bicolor	Site 4, 23-VI (1)
	Cryptocephalus spp.	Site 6, 29-V (2)
		Site 11, 8-VI (2)
	Diabrotica sp.	Site 4, 23-VI (1)
		Site 5, 23-VI (2)
		Site 8, 8-VI (1)
		Site 11, 8-VI (5)
		Site 13, 22-V (1)
		Site 13, 11-VI (1)
	Disonycha sp.	Site 13, 11-VI (3)
	Neolema sp.	Site 13, 11-VI (1)
	Pachybrachus sp.	Site 8, 8-VI (1)
		Site 11, 8-VI (12)
	unidentified spp.	Site 6, 23-VI (4)
		Site 8, 8-VI (1)
		Site 11, 8-VI (3)
		Site 12, 11-VI (1)
		Site 13, 17-IX (1)
Curculionidae	Callirhopalus sp.	Site 13, 17-IX (6)
	Centrinaspis sp.	Site 4, 29-V (1)
		Site 4, 23-VI (5)
		Site 7, 28-VIII (17)
		Site 13, 22-V (1)
		Site 13, 11-VI (14)
		Site 13, 17-IX (15)

		Lixus concavus	Site 4, 29-V (4) Site 13, 22-V (1)
		Phyrdenus divergens	Site 13, 11-VI (1)
		Rhodobaenus tredecimpunctatus	Site 12, 11-VI (1)
		unidentified spp.	Site 6, 23-VI (1) Site 11, 8-VI (1) Site 12, 11-VI (1) Site 13, 22-V (1) Site 13, 11-VI (2)
Hymenoptera	Braconidae	unidentified	Site 1, 14-VII (2) Site 4, 23-VI (1) Site 6, 29-VI (1) Site 7, 28-VIII (4) Site 13, 17-IX (1)
	Ichneumonidae	unidentified	Site 2, 14-VII (1) Site 6, 29-V (1) Site 13, 22-V (1)
	Eupelmidae		
	Chalcididae	unidentified	Site 7, 28-VIII (1) Site 13, 17-IX (1)
	Gasteruptiidae	*Gasteruption* sp.	Site 13, 22-V (1)
	Perilampidae	*Perilampus* sp.	Site 7, 28-VIII (4)
	Chrysididae	unidentified	Site 4, 23-VI (1) Site 7, 28-VIII (1)
	Formicidae	*Camponotus* spp.	Site 4, 23-VI (1) Site 5, 23-VI (1) Site 6, 23-VI (2) Site 8, 8-VI (1) Site 9, 8-VI (1)
		Formica spp.	Site 1, 14-VII (7) Site 2, 14-VII (2) Site 4, 23-VI (4) Site 6, 23-VI (12) Site 6, 29-V (4) Site 8, 8-VI (5) Site 9, 8-VI (2)

		Site 10, 29-V (12)
		Site 10, 8-VI (4+4)
		Site 11, 8-VI (5)
		Site 12, 11-VI (2+12)
		Site 13, 22-V (42)
		Site 13, 11-VI (19)
		Site 13, 17-IX (25)
	Lasius sp.	Site 2, 14-VII (14)
		Site 4, 29-V (30)
		Site 4, 23-VI (2)
		Site 5, 23-VI (6)
		Site 10, 8-VI (3)
		Site 11, 8-VI (1)
		Site 12, 11-VI (14)
		Site 13, 22-V (9)
		Site 13, 11-VI (1)
		Site 13, 17-IX (38)
	Leptothorax sp.	Site 4, 29-V (1)
		Site 4, 23-VI (2)
		Site 5, 23-VI (4)
		Site 6, 29-V (12)
		Site 6, 23-VI (17)
		Site 8, 8-VI (6)
		Site 9, 8-VI (1)
		Site 13, 22-V (1)
		Site 13, 11-VI (2)
		Site 13, 17-IX (1)
	Paratrechina sp.	Site 6, 29-V (1)
		Site 8, 8-VI (1)
		Site 10, 8-VI (1)
		Site 11, 8-VI (3)
Tiphiidae	Myzinium sp.	Site 6, 23-VI (1)
Scoliidae	Scolia sp.	Site 8, 8-VI (1)
		Site 11, 8-VI (2)
Vespidae	Polistes spp.	Site 4, 23-VI (1)
		Site 7, 28-VIII (3)
		Site 9, 8-VI (1)
Eumenidae	Monobia sp.	Site 7, 28-VIII (2)

	unidentified	Site 3, 14-VII (1)
		Site 6, 23-VI (1)
		Site 7, 28-VIII (2)
		Site 12, 11-VI (2)
Sphecidae	unidentified	Site 3, 14-VII (1)
		Site 7, 28-VIII (13)
		Site 9, 8-VI (1)
		Site 12, 11-VI (3)
		Site 13, 22-V (1)
		Site 13, 11-VI (1)
Colletidae	*Hylaeus* sp.	Site 4, 29-V (1)
		Site 4, 23-VI (1)
		Site 6, 23-VI (2)
		Site 13, 22-V (1)
		Site 13, 11-VI (1)
Halictidae	*Agapostemon* sp.	Site 12, 11-VI (1)
	Augochlora sp.	Site 4, 23-VI (4)
	Halictus sp.	Site 3, 14-VII (1)
		Site 6, 23-VI (1)
		Site 12, 11-VI (3)
		Site 13, 11-VI (1)
	Lasioglossum spp.	Site 4, 23-VI (64)
		Site 5, 23-VI (1)
		Site 6, 23-VI (19)
		Site 7, 28-VIII (106)
		Site 8, 8-VI (5)
		Site 12, 11-VI (1)
	Sphecodes sp.	Site 2, 14-VII (2)
		Site 6, 23-VI (1)
	unidentified	Site 7, 28-VIII (2)
Andrenidae	*Andrena* sp.	Site 4, 29-V (1)
		Site 13, 29-V (5)
Megachilidae	*Megachile* sp.	Site 8, 8-VI (1)
Anthophoridae	*Nomada* sp.	Site 13, 11-VI (1)
Apidae	*Apis mellifera*	Site 7, 28-VIII (3)

Apiary Inspection Program

Donald I. Hopkins and Glenn D. Hackney

In 1998, we initiated the Honey Bee Diagnostic Laboratory, which will give us the capability for more definitive diagnosis of bee afflictions than previously, and the opportunity to run quality assurance on our ETO fumigation chamber. An additional goal is to test colonies for the presence of pathogens before symptoms become apparent. During January and February most of our time was spent running the fumigation chamber, teaching classes, and planning the State Fair. In March, two inspectors together with several master beekeepers had the opportunity to go to West Virginia to teach a two-day course in Basic Beekeeing. The spring NCBA meeting was held March 6 and 7 in Albemarle, N.C., where featured speaker Logan Williams lectured on methods of keeping solitary bees.

During April and May the routine inspections of beehives were well under way. The inspectors assisted the Beekeepers Association in demonstrating honey handling at the zoo in Asheboro. Workshops as well as bee cage demonstrations were held during May and June in a variety of North Carolina locations. In mid-June, we received word that the hive beetle, a potential new pest of honey bees, had been discovered in Florida. In July, three of our inspectors had the opportunity to attend a meeting of the South Carolina Beekeepers Association in Clemson, South Carolina, at which it was made clear that the beetle had already spread to the Charleston area, and had probably been in this area since at least the previous summer. Upon return from the meeting in South Carolina we initiated an effort to determine whether this beetle had reached North Carolina.

At the NCSBA summer convention, Florida State Apiarist Mr. Laurence Cuts reported on the potential threat posed by this insect. During the course of the meeting, we contacted a beekeeper from the Charleston, SC area and made arrangements to see first hand the damage caused by this new pest. On August 19, three of our inspectors went to Charleston and determined that this insect was indeed a threat to North Carolina beekeeping.

In the ensuing months, most of our efforts were directed to surveying areas where this beetle was most likely to first arrive in North Carolina. These areas were the coastal plain, where soil conditions appeared to be favorable for development of the beetle, and the counties bordering South Carolina. Apiaries with bees from states known to have established populations of beetle were also surveyed. These surveys were conducted during the months of August, September, and October; suspect beetles were identified by NCDA & CS taxonomist Ken Ahlstrom.

The honey show at the Triad Farmers Market in Greensboro during Labor Day weekend was a great success. In late September, Jack Hanel coordinated our efforts at the Mountain State Fair, and Don Hopkins worked with the ARS Westlaco labs (Savannah, GA) in a project designed to assist the package industry in dealing with the small hive beetle. Activities during October included another demonstration at the zoo, and preparing for and displaying at the North Carolina State Fair.

The activities of the Apiary Program usually wind down by November, but 1998 was an exception. On November 23, we received a call from a new beekeeper concerned about the small hive beetle. He was located in an area contiguous with South Carolina and near the coastal plain; his bees had been purchased from an area of known infestation. Upon inspection, it became evident that the colony in question was indeed infested with the beetle. On November 24, a sample of adult beetles from the hive was transferred to the Beneficial Insects Quarantine Facility, where studies are currently in progress. On November 25, a meeting was held to develop a plan of action in response to this new pest. Some of the actions implemented at this meeting were: 1) applying for a section 18 on coumaphos, 2) supporting Florida in their efforts to obtain the same, 3) sending a letter to all the known beekeepers in North Carolina, 4) conducting a delimiting survey in the area where the beetle had been found, 5) and destroying the originally infested colony if no other infested colonies were found.

The delimiting survey was initiated on November 30 and involved all of the inspectors as well as the biocontrol administrator. The first apiary visited was approximately six to eight miles east of the initial find; beetles were present at this site. By the end of this week, beetles had been found in much of Scotland County as well as in singular locations in Robeson County and Richmond County. Inspections continued in that area as long as weather permitted.

Despite this new threat, beekeeping remains a viable industry in North Carolina; our goal is to ensure that it remains not only viable but also vigorous.